

Ensuring sustainable urban governance: Insights from service delivery in Kerala

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Abstract

Sustainability is a critical issue for local governments globally, and India is no exception. To tackle issues like climate change, air pollution, and energy security, local governments in India must adopt and enact sustainable policies and initiatives. Urban services, such as transportation, water supply, sewage management, pollution control, and solid waste management, are crucial for citizens' well-being and quality of life. Urban local bodies in Kerala have shifted towards sustainable practices in recent years. This study assesses the sustainability of urban local bodies in Kerala by analyzing their water supply systems, solid waste management practices, and land use patterns. Additionally, the study examines the impact of water pollution, air pollution, and noise pollution on the urban environment and identifies opportunities for sustainable future building practices. The findings of this study will improve our understanding of the current state of urban sustainability and provide recommendations for enhancing the long-term viability of urban areas.

Keywords: *Urban local self-government, Service delivery system, Kerala, Solid waste management*

1. Introduction

Urban services are the lifeline of cities, providing critical infrastructure and amenities that are fundamental to the daily lives of citizens. In India, rapid urbanization and population growth have exerted significant pressure on these services, leading to environmental challenges and

impeding sustainable development. The importance of urban services in fostering sustainability and enhancing the quality of life is paramount. Despite various initiatives by cities and municipalities, there remains an urgent need for further improvements and new measures to promote sustainability in urban services. A multi-faceted approach involving government, private sector, civil society organizations, and citizens is crucial to address these challenges (Bahadure & Bahadure, 2012). In India, local governments play a vital role in promoting sustainability and delivering urban services. The increasing need to confront issues like climate change, air pollution, and energy security has prompted local governments to implement policies and programs that support sustainability (Randhawa & Kumar, 2017). In Kerala, municipal corporations have made significant strides towards sustainable practices in land use, water service, and solid waste management. Initiatives such as organic farming, rainwater harvesting, and waste segregation have been introduced. However, the state continues to grapple with water, air, and noise pollution due to the unregulated use of pesticides and fertilizers and the lack of proper waste management infrastructure. Sustainable urban services not only contribute to environmental preservation but also to economic development and social well-being. They provide citizens with improved access to basic services, create employment opportunities, and promote social equity. This, in turn, helps in reducing poverty and enhancing the quality of life. The primary objective of this study is to assess the sustainability of urban local bodies by examining their water supply systems, solid waste management practices, and land use patterns. It will also evaluate the feasibility of implementing sustainable building practices by analyzing the effects of water, air, and noise pollution on the urban environment. The study aims to offer insights into the current state of urban sustainability and propose recommendations for fostering long-term sustainability in urban areas.

2. Methodology

The objective of this research study was to assess the sustainability of service delivery practices implemented in urban local bodies in Kerala. To achieve this aim, a comprehensive approach was adopted, utilizing both primary and secondary sources of data. The primary data was collected through structured questionnaires and semi-structured interviews with a range of stakeholders, including government officials, administrators, elected representatives, and citizens. Furthermore, secondary data was gathered from various sources, such as reports from local, state, and central governments, as well as external agencies such as the World

Bank and Asian Development Bank, magazines, and newspapers. For this study, a representative sample of four municipal corporations in Kerala was selected, namely Thiruvananthapuram, Kollam, Thrissur, and Kozhikode, out of a total of six municipal corporations in the state. The selection process for the sample took into account various factors, including geographic distribution, city size, and data availability. Descriptive statistics and thematic analysis were used to analyse the data collected through structured questionnaires, semi-structured interviews, and secondary sources, to identify patterns, trends, and relationships. The results obtained from the analysis led to the development of meaningful conclusions and recommendations.

3. Discussion: Sustainability initiatives of urban local bodies

Local governments play a crucial role in driving sustainable development and achieving the Sustainable Development Goals (SDGs) (*Karim & Rupa, 2017*). Urban Local Bodies (ULBs) and Panchayati Raj Institutions (PRIs) in India have the potential to catalyze transformative change at the grassroots level (*Gandham et al., 2019*). In Kerala, local bodies have been at the forefront of this effort, undertaking a range of initiatives to promote sustainability and environmental protection. One of the key focus areas has been localizing the SDGs to address the specific needs and priorities of each region (*Localizing SDGs in Kerala – KILA, n.d.*). Local bodies in Kerala have formulated localized SDG implementation plans, with a focus on poverty alleviation, food security, universal healthcare, water and sanitation, disaster resilience, and climate action. This context-specific approach has enabled more effective and impactful interventions. In the realm of agriculture, local governments have actively promoted sustainable practices, such as organic farming, zero-budget natural farming, and biodiversity conservation. These efforts have led to a substantial reduction in the use of chemical fertilizers and pesticides, contributing to a more environmentally-friendly food production system

Local bodies have also made significant strides in renewable energy generation, establishing biogas plants, solar power projects, and micro-hydel projects to meet local energy demands through green sources. Waste management has been another area of focus, with the implementation of decentralized solid waste management systems and the Haritha Keralam Mission, which aims to make Kerala a clean and green state. Addressing water and air pollution has been a top priority for Kerala's

local governments. They have implemented measures to control industrial effluents and domestic sewage discharge, conserve water resources, and reduce vehicle emissions and noise pollution (Joseph et al., 2020; Neeraja, 2019). These initiatives have helped safeguard the quality of rivers, lakes, and coastal areas, as well as improve the overall environmental health of communities. Additionally, local bodies have worked to develop pedestrian-friendly and cycle-friendly infrastructure, promoting green transportation and enhancing the quality of urban spaces. Tree planting and the creation of green spaces have also been part of their efforts to improve air quality and create more livable communities. The proactive role played by local bodies in Kerala exemplifies the significant impact that effective and autonomous local governance can have on sustainable development (*Haritha Keralam – Haritha Keralam*, n.d.). By addressing critical environmental and social challenges, these local initiatives have empowered communities and paved the way for a more sustainable and resilient future. This approach can serve as a model for other regions, demonstrating the vital role of local governments in realizing the broader global vision of sustainable development.

3.1. Land use in the urban local bodies of Kerala

Sustainable land use practices are crucial for achieving holistic and long-term development, and local governments play a pivotal role in this regard. Kerala's municipal corporations have undertaken commendable initiatives to promote sustainable land use, recognizing the close link between land use and sustainable development. One of the key focus areas has been the implementation of sustainable land use programs, including the creation of master plans, zoning rules, and development control regulations. These initiatives have helped reduce garbage generation and encouraged recycling, composting, and waste segregation, thereby creating more sustainable ecosystems and land use patterns (Verburg et al., 2015; Dale, 1997; Patricia E. Salkin, 2009). Reforming land use laws has also been a priority, as it is essential for building sustainable communities and promoting resource conservation (Projects and Programmes Strengthening State Land Use, n.d; Salvador & Sancho, 2021). The analysis of land use patterns in four major municipal corporations in Kerala – Thiruvananthapuram, Thrissur, Kozhikode, and Kollam – reveals interesting insights (Table 1). Residential land use is the predominant land use, ranging from 39.32% in Thrissur Municipal Corporation to 72.84% in Kollam Municipal Corporation. This high percentage of residential land use can have adverse environmental impacts, such as reducing biodiversity and harming the natural environment.

Land Uses	Thiruvananthapuram	Thrissur	Kozhikode	Kollam
Residential	56	39.32	68	72.84
Agriculture	22	33.04	2.07	1.24
Paddy not cultivated	1	-	0.45	-
Public and semi-public land	13	10.17	4.7	5.5
Transportation	3	5.97	5.43	5.58
Waterbody	3	3.34	6.5	5.75
Commercial	1	1.6	2.89	2.13
Industrial	1	1.64	1.5	1.81
Park and open spaces	-	0.54	0.64	3.07
Others	-	4.38	7.82	2.08

Source: Master Plan of respective Municipal Corporations. (Thiruvananthapuram Municipal Corporation: Thiruvananthapuram Master Plan draft, Thrissur Municipal Corporation: Master plan for Thrissur City, Kozhikode Municipal Corporation: Master Plan for Kozhikode Urban Area – 2035, Kollam Municipal Corporation: City Development Plan for Kollam- 2041)

In contrast, the percentage of agricultural land use is relatively low, ranging from 1.24% in Kollam Municipal Corporation to 33.04% in Thrissur Municipal Corporation. All of them have a comparatively low percentage of agricultural land used, mostly as a result of the trend toward the conversion of agricultural land for residential and commercial uses. In order to maintain the natural environment and guarantee food security, agricultural land must be preserved. (Governance of Land Use - OECD, n.d.). Preserving agricultural land is crucial for ensuring food security and maintaining the natural environment. Municipalities like Thrissur and Thiruvananthapuram, with higher percentages of agricultural land use at 33.04% and 22% respectively, present opportunities for promoting sustainable agricultural practices and biodiversity conservation. The distribution of transportation and public and semi-public land use is relatively uniform across the municipalities, ranging from 3% to 5.97% for transportation and 4.7% to 13% for public and semi-public land use. To lower carbon emissions and enhance public health, however, sustainable transportation options like bicycling and public transportation must be given priority. Municipalities can explore policies and infrastructure investments that encourage sustainable mobility and reduce reliance on private vehicles (Local Governments and Sustainability: The Power of Public Goods - PA Times Online, n.d.). The variations in land use patterns across the municipalities highlight the importance of tailored land use management policies that address the unique characteristics

and needs of each region (Towards Sustainable Land Use, 2020). For instance, Thrissur's high percentage of agricultural land use may call for policies that prioritize sustainable farming practices, while Kollam's significant public and semi-public land use could focus on promoting green infrastructure and improving public transport connectivity. By embracing sustainable land use practices, Kerala's municipal corporations are setting an example for other regions, demonstrating the transformative impact that local governments can have on achieving sustainable development goals. This approach emphasizes the critical role of effective and autonomous local governance in shaping a more sustainable and resilient future (Sustainable Land Management | Food and Agriculture Organization of the United Nations, n.d.).

3.2. Water supply system and structure in the urban local bodies of Kerala

Water management is a critical aspect of sustainable urban development, and Kerala's municipal corporations have taken significant strides in this regard. The water supply system in Kerala is primarily managed by the Kerala Water Authority (KWA), a state-level agency responsible for water distribution across the state, with local bodies like municipal corporations also playing a vital role in water supply management within their jurisdictions (Kerala Water Supply and Sewerage Act 14 of 1986 Amendments and Other Regulations, n.d; Performance Report: Kerala Water Authority, n.d.). An analysis of the water supply sources reveals interesting insights. In Thiruvananthapuram and Kollam, the KWA or the municipal corporation is the predominant source of water, accounting for 81% and 76.62% of the total water supply respectively. This indicates a centralized and organized approach to water management in these cities, with a significant proportion of the population relying on a single, regulated source (Performance Report: Kerala Water Authority, n.d.). In contrast, Thrissur stands out with a high reliance on individual wells, with 80.43% of its water supply coming from this decentralized source. This suggests a more self-sufficient and decentralized approach to water sourcing within the municipality. The use of public water supply and public bore wells is more evenly distributed across the municipalities, with Thrissur exhibiting the highest reliance on this source at 4.31%. The capacity of water storage reservoirs also varies significantly across municipal corporations. Thiruvananthapuram has a storage capacity of 63.25 million liters, while Kozhikode has a much lower capacity of only 10.8 million liters (Manual of Resident Audit office, Kerala Water Authority (First Edition), n.d.). Effective management and utilization of these water resources are crucial to ensure a

sustainable and equitable water supply to meet the growing demands of Kerala's population. The analysis also reveals the use of other sources, such as rivers, which account for a small percentage of the water supply in Kozhikode and Kollam. This diversification of water sources suggests an effort to incorporate surface water resources into the municipal water supply systems.

Sources of water	Thiruvananthapuram	Thrissur	Kozhikode	Kollam
Kerala Water Authority/ or corporation	81	30.57	30	76.62
Own well	10	80.43	64.2	12.37
Public water supply/public bore well	5	2.29	4	4.31
other sources	4	-	1	5.49
River	-	0.01	0.08	1.21
<i>Source: Master plan of respective municipal corporations</i>				

The variations in water source distribution and storage capacity across municipal corporations highlight the importance of tailored water management strategies that address the unique challenges and opportunities of each region. Local bodies, in collaboration with the KWA, must continue to invest in improving the efficiency and sustainability of the water supply system, ensuring equitable access to clean and reliable water for all. Addressing water management challenges, such as physical losses and water scarcity, is crucial for the long-term viability and well-being of these urban centers (Kerala Water Supply and Sewerage Act 14 of 1986 Amendments and Other Regulations, n.d.). Proactive steps, including reducing physical losses and implementing comprehensive water conservation measures, must be taken to ensure the sustainability of the water supply networks. The government's role in overseeing and supporting the municipal corporations' water management efforts is essential in this regard. By addressing water management issues and promoting sustainable water practices, Kerala's municipal corporations can set an example for other urban areas, demonstrating the pivotal role of local governance in achieving sustainable development goals and ensuring the long-term resilience of communities.

3.2.1 Groundwater management

Groundwater management is a critical component of sustainable water resource management in Kerala, which has faced challenges such as the decline of river systems, loss of wetlands and paddy fields, increasing demand, over-exploitation, and pollution (Varma, n.d.). Groundwater is a significant resource for achieving universal access to drinking water,

sanitation, and hygiene, as highlighted in the Sustainable Development Goals, Groundwater is managed by both government and private entities and is used by millions of farmers in Kerala. It is also essential for irrigation, accounting for 43% of all water used for this purpose globally (Varma, n.d.) (The Importance of Groundwater - The Groundwater Project, n.d.). The analysis of groundwater recharge and monsoon contribution in the municipal corporations and districts of Kerala provides valuable insights. The estimation of dynamic groundwater resources of Kerala as of March 2020, as per GEC-2015 recommendations, was approved in the 2nd meeting of the State Level Committee for the re-establishment of groundwater resources of Kerala on 26.7.21(Varma, n.d.). The occurrence and movement of groundwater in various litho-units underlying the state are influenced by different terrain units. The depth to the water level in the aquifer varies from 2 to 16 mbgl, and the yield of the well ranges between 2 to 10 m³ per day. Exploratory drilling was carried out by the Central Ground Water Board in the state in the crystalline overburden and the wells situated at elevated areas. The spatial distribution of groundwater levels in Kerala is shown in Figure 4 of the Dynamic Ground Water Resources of Kerala (2020) report. One of the primary ways in which groundwater is recharged is through rainfall. The pre-monsoon and post-monsoon seasons play a vital role in determining the amount of groundwater recharge. For instance, the Thiruvananthapuram Municipal Corporation and District have a relatively lower rainfall amount of 1818.94 mm compared to other districts, yet they have a substantial total annual groundwater recharge of 5455.21 ha.m and 30003.98 ha.m, respectively. This can be attributed to their high recharge from other sources during non-monsoon seasons, demonstrating the importance of considering both rainfall and other recharge sources in the sustainable management of groundwater resources.

Assessment Unit/ District	TVM MC	TVM District	Kollam MC	Kollam district	Thrissu r MC	Thrissur district	Kozhiko de MC	Kozhikode district
Total Geographical Area of Block (Ha)	33727	218797	14703	249100	22892	302385	16351	234230
Rainfall (mm)	1818.94	1818.94	2417.69	2417.69	3176.64	3176.6	3382.46	3382.46
Average Pre-monsoon Water level (mbgl)	8.68	9.17	7.31	7.68	10.36	6.53	4.67	5.21
Average Post monsoon Water Level (mbgl)	6.9	7.44	5.97	5.84	9.02	4.9	3.29	3.66
Recharge from rainfall during the monsoon season	4299.22	21075.45	2651.36	27361.75	3629.66	45874.26	2472.27	31186.83

Recharge from other sources during the monsoon season	32	570.29	135.54	827.06	129.9	840.67	34.86	398.96
Recharge from rainfall during non-monsoon season	986.47	5623.81	349.33	6564.38	116.98	1999.45	365.65	1565.21
Recharge from other sources during non-monsoon season	137.52	2734.43	345.38	2771.53	1922.63	14282.56	143.74	1437.35
Total Annual Ground Water Recharge	5455.21	30003.98	3481.61	37524.72	5799.17	62996.94	3016.52	34588.35
<i>Source: Groundwater resource of Kerala</i>								

In contrast, the Kollam Municipal Corporation, while receiving a higher rainfall of 2417.69 mm during the monsoon season, has a lower total annual groundwater recharge of 3481.61 ha.m due to a lower recharge from other sources during non-monsoon seasons. This highlights the need for a nuanced understanding of the factors influencing groundwater recharge in different regions. The Kozhikode Municipal Corporation, with a higher rainfall of 3382.46 mm during the monsoon season, has a lower total annual groundwater recharge of 3016.52 ha.m compared to other municipal corporations, underscoring the importance of considering factors beyond rainfall, such as recharge from other sources during non-monsoon seasons. The Thrissur Municipal Corporation stands out with the highest rainfall of 3176.64 mm during the monsoon season and a substantial total annual groundwater recharge of 5799.17 ha.m, contributing nearly 20% of the total annual groundwater recharge in the district. This can be attributed to a combination of high recharge from rainfall during both monsoon and non-monsoon seasons, as well as recharge from other sources during non-monsoon seasons. The comparative analysis of groundwater recharge across municipal corporations and districts in Kerala highlights the importance of adopting a comprehensive and context-specific approach to groundwater management. Factors such as rainfall, recharge from other sources, and the relative contribution of each municipal corporation to the district-level performance must be considered to develop effective and sustainable groundwater management strategies. This understanding is crucial for ensuring the long-term availability and equitable distribution of this vital resource.

3.3 Solid waste management in the urban local bodies of Kerala

Solid waste management has emerged as a critical challenge for urban local bodies in Kerala, and the state has made concerted efforts to address this issue. The state government has partnered with international organizations like the Asian Development Bank and the World Bank to enhance access to efficient and reliable solid waste management services in urban

areas. (Kerala Sustainable Urban Development | ADB, 2005; India: Kerala Solid Waste Management Project- AIIB, n.d.). The World Bank has also approved a \$105 million project aimed at strengthening the state's solid waste management systems, focusing on operational, financial, and environmental sustainability while improving flood resilience (Solid Waste Management Systems in Kerala, India, World Bank, n.d; *World Bank Approves \$105 Million Project to Strengthen Solid Waste Management Systems in Kerala, India, n.d.*). One of the key initiatives is the 'Haritha Kerala Mission,' launched by the Government of Kerala, which places significant emphasis on solid waste management. This comprehensive framework involves collaboration between businesses, governments, and academic institutions to create integrated solutions that engage all stakeholders in effectively managing solid waste (Anuardo et al., 2022). The data on the composition of solid waste in four major municipal corporations in Kerala reveals that domestic waste is the dominant source, accounting for the highest percentage in Thrissur at 63.76%, followed by Thiruvananthapuram at 57%, Kollam at 55.88%, and Kozhikode at 47%. Another significant source of waste is commercial waste, with Kozhikode having the highest percentage at 24%, followed by Thrissur at 22.73%, Kollam at 10%, and Thiruvananthapuram at 8%. Restaurants and hotels also contribute a considerable amount of waste, particularly in Kollam (11.18%) and Kozhikode (7%). The market is another notable source of waste, with Kozhikode (6%), Thrissur (5.78%), and Kollam (3.53%) demonstrating higher percentages. Slaughterhouses are also a source of waste, with Kozhikode having the highest percentage at 4%, and Kollam the lowest at 1.18%.

Solid Waste Compositions	Thiruvananthapuram	Thrissur	Kozhikode	Kollam
Domestic	57	63.76	47	55.88
Street sweeping	16	-	10	8.24
Commercial	8	22.73	24	10
Restaurants Hotels	6	-	7	11.18
Market	5	5.78	6	3.53
Slaughterhouses	2	3.12	4	1.18
Schools & Institutions	1	-	-	4.12
Hospital	-	2.18	2	1.18
others	6	2.43	-	4.71

Source: Same as Table 1

These findings suggest that while domestic waste is a significant challenge across all municipal corporations, the relative importance of other waste sources, such as commercial, restaurants, hotels, and markets, varies among the municipalities. This indicates the need for

a tailored and context-specific approach to solid waste management in each local body. The innovative solutions adopted by Thiruvananthapuram and Alappuzha serve as examples of how local governments can effectively address the solid waste management challenge. Thiruvananthapuram's campaign to encourage residents to better manage their waste, including the distribution of compost bins, and Alappuzha's pilot project on using slurry from bins as fertilizer, demonstrate the potential for community-driven and decentralized approaches to solid waste management (The Tale of Two Cities: Two Kerala Models for Waste Management | Policy Circle, 2020; Navigating Alleppey's Obstacle Course of Waste Management: 'It's Up to Us to Change That' | Pulitzer Centre, n.d.). The state-wide "Haritha Keralam" program, aimed at making Kerala garbage-free by 2020 through decentralized composting and recycling units at the panchayat level, further underscores the commitment of the Kerala government to addressing the solid waste management crisis in the state. This holistic approach, involving multiple stakeholders and a focus on sustainable solutions, can serve as a model for other regions grappling with similar challenges.

3.4 Water pollution in the urban local bodies of Kerala

Water pollution is a critical environmental issue plaguing the urban local bodies of Kerala, despite the region's abundant water resources, rapid urbanization, industrialization, and inadequate waste management systems have led to the deterioration of water quality in these areas. In Thiruvananthapuram, the primary sources of water pollution are domestic sewage, industrial effluents, and agricultural runoff. The city produces approximately 207 million liters of sewage daily, but only about 80% of it undergoes treatment before being discharged into water bodies. The pollution from industrial activities is also substantial, with around 5,000 small-scale and 100 large-scale industries operating in the area. The Karamana River is heavily contaminated with sewage and industrial waste, making it the primary source of water pollution (Report by the Kerala State Pollution Control Board, 2017). To combat this issue, the Thiruvananthapuram Municipal Corporation has initiated several projects, including the construction of sewage treatment plants, biogas plants, and rainwater harvesting systems, as well as the implementation of strict regulations to limit the discharge of industrial waste into water bodies. In Kollam, the Ashtamudi Lake is facing a significant threat of water pollution due to untreated sewage and industrial waste discharge. The city generates approximately 44 million liters of sewage daily, but only 40% of it undergoes treatment. Additionally, small-scale industries, such as cashew processing units, discharge untreated

effluents into the water bodies (Report by the Kerala State Pollution Control Board, 2017). The Kollam Municipal Corporation must take immediate measures to enhance its sewage treatment infrastructure and ensure that small-scale industries treat their effluents before discharging them into water bodies (City Development Plan for Kollam- 2041, 2014).

Thrissur Municipal Corporation is also grappling with water pollution caused by the discharge of industrial effluents, domestic sewage, and agricultural runoff. The city's 21 canals, which serve as a means of transportation and drainage, are heavily contaminated with sewage and solid waste, posing serious health risks to residents in nearby areas. Daily sewage production in Thrissur is approximately 65 million liters, but only 40% of it is treated before being released into water bodies. The Athani industrial estate is a significant source of industrial pollution in the city (Master Plan for Thrissur City drinking water, n.d.; Environment Master Plan for Thrissur City, n.d.). In Kozhikode, the discharge of untreated sewage and industrial effluents into water bodies has resulted in significant water pollution issues. The Kallai River and the Canoli Canal are the primary sources of water pollution, with heavy metals and organic chemicals heavily contaminating them. The city generates 150 million liters of sewage daily, but only 60% is treated. Small-scale industries, such as textiles and food processing, also contribute to the problem by releasing untreated effluents into the water bodies (Master Plan for Kozhikode Urban Area – 2035, n.d.). These urban local bodies have taken various measures to address water pollution, including the construction of sewage treatment plants, the implementation of strict regulations, and the promotion of community participation and education. However, more comprehensive and sustained efforts are required to tackle the root causes of water pollution and ensure the long-term sustainability of the region's water resources (Kozhikode Corporation to Act Tough against Those Polluting Drains Times of India, (2016); Master Plan for Kozhikode Urban Area – 2035, n.d.).

3.5 Air and noise pollution in the urban local bodies of Kerala

Urban local bodies in Kerala are grappling with the critical environmental issues of air and noise pollution. These challenges not only pose a threat to human health but also have detrimental effects on the environment and the economy. Tackling these problems is essential for the pursuit of sustainable development in the region. In Thiruvananthapuram, the capital city, air pollution is a major concern, with average PM_{2.5} levels of 25.6 µg/m³, as reported by IQ Air (*Thiruvananthapuram Air Quality Index (AQI) and India Air Pollution / IQAir, n.d.*). The primary sources of air pollution are vehicular and industrial emissions, as well as

biomass burning. Traffic congestion caused by a high volume of vehicles on the roads is a major contributor, and industrial areas like Technopark also significantly contribute to air pollution. Noise pollution from vehicular traffic, construction work, and public speakers is also a significant concern, with the Palayam market experiencing high noise levels during peak hours *S M Maya & C Sreedevi, 2015*; Thiruvananthapuram Corporation Master Plan, n.d.). The Kollam Municipal Corporation faces similar challenges, with heavy vehicular traffic, industrial activities, and ongoing construction projects contributing to air and noise pollution. The presence of small-scale industries, particularly cashew processing units that use coal and wood as fuel, as well as brick kilns, worsens the air quality (Kerala State Pollution Control Board PCB Kerala, n.d.). Noise pollution is prevalent in areas with high traffic density and commercial activities (City Development Plan for Kollam, 2041, 2014). In Thrissur, air pollution is primarily caused by the high number of vehicles and industries, including large and small-scale textile mills, that emit considerable amounts of particulate matter and other pollutants. Construction activities in the city also contribute to pollution levels, with the city's growing population and urbanization fueling more construction and further exacerbating air pollution (Thrissur Air Quality Index (AQI) and India Air Pollution | IQAir, n.d.). Noise pollution is also a significant concern, with traffic, construction activities, and industries contributing to high noise levels (Master Plan for Thrissur City Environment, n.d.).

Kozhikode is also grappling with air and noise pollution issues. Studies indicate that the average PM_{2.5} level in the city in 2020 was 52.2 µg/m³, which is higher than the National Ambient Air Quality Standard (NAAQS) of 40 µg/m³ set by the Central Pollution Control Board. Vehicular emissions, construction activities, and biomass burning are some of the sources of PM_{2.5} in the city. Additionally, the average NO₂ concentration in Kozhikode in 2020 was 25.9 µg/m³, which exceeds the NAAQS of 20 µg/m³ city (Calicut Air Quality Index (AQI): Real-Time Air Pollution | Kerala, n.d.) (Kerala State Pollution Control PCB Kerala, n.d.). To address these challenges, municipal corporations have implemented various measures, including deploying air quality monitoring systems, promoting the use of public transportation and clean energy, imposing strict regulations on construction sites, and prohibiting the use of loudspeakers after specific hours. However, the progress in reducing pollution levels has been slow, highlighting the need for more coordinated and sustained efforts. Effective enforcement of regulations, stakeholder engagement to promote behavioral change, and the adoption of innovative solutions are crucial for addressing the root causes of air and noise pollution (Noise Pollution is a Major Problem, Both for Human Health and the

Environment- European Environment Agency, 2020.). Transitioning towards cleaner energy sources, sustainable transportation, and circular economy practices can help create a more sustainable future. By taking a holistic and collaborative approach, municipal corporations can lead the way in mitigating the adverse impacts of air and noise pollution and promoting environmental sustainability.

4. Policy interventions at the urban local bodies level

Kerala's journey towards sustainable development is marked by its rich resources and educated population. Despite these advantages, the state has struggled with the practical application of sustainable practices state (*Towards Kerala's Sustainable Development- The New Indian Express, 2022*). In response, the Government of Kerala has initiated several projects, such as the Kerala Sustainable Urban Development Project (KSUDP), which is a Special Purpose Vehicle designed to enhance urban infrastructure in a sustainable way. This project has garnered support from both the Government of India and the Asian Development Bank. Additionally, KSUDP has been designated as the State Level Nodal Agency for the UIG and UIDSSMT under the Jawaharlal Nehru National Urban Renewal Mission (*Kerala Sustainable Urban Development Project | Local Self Government Department, n.d.*). The state's Responsible Tourism (RT) Mission is another significant initiative that seeks to harness tourism for the development of local communities, poverty reduction, and women's empowerment, all while maintaining a balance between economic, social, and environmental sustainability (*Responsible Tourism Mission - Kerala Tourism Mission, n.d.*). To bolster its preparedness for natural disasters, Kerala has implemented strategic urban planning, investment budgeting, and emergency management systems, supported by a \$125 million program from the World Bank aimed at enhancing the resilience of the agricultural and road sectors to climate-related challenges (World Bank Approves \$125 Million Program to Support a Green and Resilient Kerala, 2021). Addressing the pressing issues of land use, water supply, waste management, and pollution is crucial for Kerala's sustainable urban development. The state's policies are now geared towards encouraging mixed-use development, improving water supply and distribution, and establishing effective waste management systems that focus on segregation, recycling, and composting. The 2023-24 budget reflects Kerala's commitment to sustainable and modern development, with initiatives like 'Nava Kerala', energy parks, and the Kerala Solid Waste Management Project (Government of Kerala budget speech 2022-2023, 2022; Kerala Budget Analysis 2023-24,

2023.). However, the state's financial commitments, particularly towards employee salaries and pensions, which account for a significant portion of the budget, present a challenge to sustainable asset creation and future development. It is imperative that all stakeholders, including local governments, the private sector, and civil society, collaborate to foster innovation, utilize technology in addressing urban challenges, and prioritize education, healthcare, gender equality, and poverty reduction. This collective approach is essential for shaping a sustainable future for Kerala.

5. Conclusion

Kerala's municipal corporations have made significant strides in creating a sustainable future through their efforts in land use management, water service delivery, and solid waste management. The implementation of policies and programs such as organic farming, rainwater harvesting, and waste segregation have yielded positive results. Still, the state has problems with noise, water, and air pollution. Land and water resources have been contaminated as a result of excessive fertilizer and pesticide use in agriculture as well as a lackluster waste management infrastructure. In the meantime, air and noise pollution in urban areas negatively impacts residents' health and well-being.. While municipal corporations have made progress, there is still much work to be done to achieve a truly sustainable future. A comprehensive and integrated approach, fostering better coordination and collaboration among government agencies, the private sector, and civil society organizations, is crucial. By encouraging the use of innovative technologies and practices, stakeholders can work together to reduce the negative impact of human activities on the environment. To achieve a sustainable future, it is essential to focus on creating better land use management practices, improving water service delivery, and implementing more effective solid waste management. Promoting mixed-use development can reduce commuting distances and encourage walkability, while rainwater harvesting systems can make use of Kerala's heavy rainfall. Efficient water distribution networks can reduce water loss and ensure equitable access to clean water for all residents. The utilization of smart city technologies can also play a role in optimizing traffic flow and reducing energy consumption in buildings. Encouraging the use of public transportation, cycling, and electric vehicles can further reduce the number of vehicles on the road and cut carbon emissions. The journey toward a sustainable future is complex and challenging, but continued efforts by all stakeholders can create a cleaner, greener, and more livable future for everyone. By adopting a collaborative approach and

leveraging innovative technologies and practices, stakeholders in Kerala can work towards achieving a truly sustainable future.

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